SCIENCE AND THE PLOW

Talk by Dr. Byron T. Shaw, Administrator, Agricultural Research Service, U. S. Department of Agriculture, for the dedication of the new facilities at the National Tillage Machinery Laboratory, Auburn, Ala., May 17, 1963.

One of my special pleasures as research administrator is taking part in the dedication of new facilities for research.

Buildings such as this addition to the National Tillage Machinery Laboratory represent years of planning and effort by many dedicated people. It is deeply satisfying to view the finished product with all the promise that it holds for American agriculture. These new facilities will permit us to move along much more rapidly in tillage research and add to our growing knowledge of the world around us.

At a time like this, it is natural to take stock -- to see where we stand today in tillage research and look ahead to see where we are heading.

The recent explosive growth of science -- with its great emphasis on problem solving through organized study -- is changing tillage as it is changing everything else in agriculture. The opening of the National Tillage Machinery Laboratory here in Auburn in 1935 instituted a period of great activity and progress in this field. The last few years alone have seen some interesting new advances.

Scientists here have found a way to measure the relative efficiency of widely differing methods of tilling -- from simple hand-spading to complicated roto-tilling. We can now measure the energy used by any particular tillage method to produce a standard-size clod -- and compare this with the energy used to produce the same size clod by dropping the soil from various heights. This simple yet effective laboratory technique can help us greatly in evaluating proposals for improving tillage methods.

Our people here have come up with an original method for using analog computers to electronically reduce complicated data while tillage tests are underway. This has made test results more accurate and cut down on labor costs. This, again, is a technique that can help us do a better job in the laboratory, which means that we can eventually do a better job of helping farmers.

New discoveries have greatly improved the efficiency of tractor tires. Tires with radial-ply construction consistently did better under all soil conditions and on concrete than those with diagonal-ply construction. In some cases, the efficiency of traction increased by as much as 40 percent. We feel confident that continued improvements can be made in tractor tire efficiency by changing the design of the tires, and we will continue our efforts along this line.

Two new tillage tools -- a cotton bed blade and a bed leveler -- have just been developed. These should prove to be useful to growers in Southern States where cotton is planted on a raised, firm seedbed.

Changes in rolling sheet steel for disc blades have resulted in stronger, longer-lasting blades for farm equipment. Better methods of sharpening disc blades have decreased soil compaction and draft. Newly designed mounts for sub-soil equipment have reduced draft without reducing effectiveness of the equipment.

These and other contributions of tillage research through the years have helped to give us some practical insights into the extremely complex relationship of mechanized equipment, soil, and plant growth. Now -- having come this far -- we find that we are scraping the bottom of the scientific barrel. We cannot move ahead indefinitely or make any really significant contributions unless we understand a great deal more about tillage than we do now. One of our problems, in fact, is to find out exactly what we <u>do</u> need to know.

We have known for a long time that farmers waste time, effort, and money on tillage practices that are unnecessary or even undesirable. Only recently, for example, our people found that corn planted in untilled sod that had been sprayed to kill the grass gave unusually high yields . . . increased moisture infiltration . . . and reduced soil erosion. Obviously, we cannot make any tillage recommendations based only upon the results of this work. But it <u>is</u> part of a growing pattern which suggest that minimum tillage is the best tillage. We don't yet understand all of the physical factors that are involved.

We are thus in the frustrating position of not knowing precisely what to tell farmers they should be doing about tillage practices, or why. We hope, with the increased emphasis on basic work here, to find some of the answers . . . to develop principles that can be used to help farmers fully utilize their equipment . . . anything from a spade or 2-horsepower tractor to the largest piece of machinery going.

Another one of our major needs is for better tillage tools and equipment. We need tools and equipment that are stronger and better able to withstand heavy wear and prevent costly breakdowns. We need to shape them for high-speed operation, modify them to prevent cone formation, and coat them with plastics or some other material to combat sticky soils and reduce power needs.

The soil-working tools and traction devices commonly used today have evolved through the years mostly by trial and error and thus are only moderately effective. There is no body of basic knowledge in this field -- only an accumulation of apparent best practices.

This lack of knowledge has kept losses high. Improper tillage practices cost farmers an estimated $100 million a year. Traction losses on rubber-tired farm tractors amount to over $80 million a year. Both could be substantially lowered if knowledge were available to design better equipment.

Here, again, basic research of the strongest kind is called for. We should be able to identify the physical factors in the soil that affect plant growth -- factors such as those that control water intake, gas exchange, depth of rooting, and heat transfer. And we should be able to determine which can be altered by tillage tools.

We must also develop measurements to determine whether or not soil requires tillage, and if so, what kind. We should develop design criteria for land-forming equipment. Among other things, we ought to consider the tolerance of the soil surface being formed, and the final density required. We ought to determine the limitations of various traction devices, taking into account the permissible levels of soil compaction and deformation, and the soil load-bearing capacity.

This brings up another problem that must be solved if farmers are to profit from tillage practices. As you know, common methods of tillage generally compact the soil and slow down plant growth. Many systems are being tried to reduce or overcome this difficulty -- lighter tractors, taking the wheel out of the furrow, trench tillage, and a till-plant system that eliminates plowing and has wheels running in the same track each year.

They have all helped to alleviate the problem somewhat. But -- despite their usefulness -- soil compaction is still a major frustration for farmers and scientists alike. More satisfactory ways of dealing with this problem still need to be worked out.

One of our major dilemmas -- one that is at the heart of nearly all tillage practices -- is that we do not know how to predict the behavior of soils under the varying forces encountered in tillage and soil moving operations.

It is extremely important that we develop general stress-strain relationships for a variety of soils at various moisture levels and rates of strain. We must work out basic guide lines that can predict the forces required to cause a particular soil to break and flow. And we ought to study in greater detail the physical and chemical properties of the soil that affect its abrasiveness and friction with various tool surfaces.

I am sure you all recognize these needs as among the most urgent in tillage research. There are, of course, many practical problems that require time and attention. But these will give way much more quickly if we can apply knowledge gained through basic research. For too long a time, tillage studies have done little else but meet day-to-day problems. Now, we've got to expand our basic work in this field -- as we are doing in most others -- in order to keep up with an increasingly complicated world, and to lay the groundwork for the future.

Now, what about this future for tillage research? What can we expect in new ideas and developments?

It takes no particular stretch of the imagination to see that tillage will be used less and less to kill weeds. This is a job that will be taken over increasingly by chemicals.

We can foresee a trend toward more power-driven tools that work the soil directly rather than through traction devices. This will add to efficiency and cut down on soil compaction.

We can foresee higher-speed operations for field equipment. This will enable a farmer to use more power and increase performance without increasing weight.

We can expect to see more in the way of separation and redistribution of soil granules and clods to provide a favorable man-made environment for growing plants. This will give the seeds and young plants an early boost in their development.

We will certainly see more specialized treatment of different soil zones -- such as the seed and root-bed zones, the water-management zone, and the transport and traction zone. These all differ markedly and require individual treatment for greatest efficiency of equipment operation.

We can expect much greater use of electronic guiding devices to control farm equipment. And, finally, we can expect new types of tires and tracks that can operate under a wide range of soil conditions.

These are only a few of the directions that tillage research will probably take in the foreseeable future. Others we cannot even predict. But we do know that as we understand more and more of the world around us, our power to extend nature's potential expands in proportion.

Tillage, of course, is only part of the vast agricultural engineering complex that has helped to make American agriculture the most efficient and productive in the world. Industry and State and Federal Governments have joined forces in a remarkably effective effort to discover, invent, and develop better ways for American farmers to do things.

Thanks to these efforts, more of our farms are mechanized today than ever before. More of our farmers are using mass-production techniques to produce commodities of uniform quality in high volume at low cost.

Harvesting and handling systems have been developed and refined for a growing number of fruits. Costs of hand labor have thus been reduced, resulting in lower costs to consumers.

Electrical equipment, such as automatic feed preparation and conveying systems and silo unloaders, has been introduced widely to reduce farm labor.

Studies on labor-saving techniques in livestock production and on animal environments have provided a storehouse of useful knowledge. Industry is using this information to develop packaged buildings and equipment for production of poultry and swine. Improved design features for dairy farms, such as loose housing and elevated stall milking facilities, have greatly increased the efficiency of dairy operations.

Agricultural engineers have developed a national farm building plan service that combines the latest developments in farm building research along with sound architectural practices. These plans are generally available to farmers through the State Extension Services.

These are only a few of the techniques being used by American farmers today to help them produce profitably and efficiently. There's still much left to be done.

We need to lower costs substantially by improving all phases of production, harvesting, and handling. Take cotton, for example.

The use of broadcast planting can cut production costs by eliminating cultivation. The use of minimum tillage techniques -- such as weed control by chemicals or by flaming and yearly re-use of previously tilled rows -- would be highly effective. Use of electromagnetic radiation to trap or kill insects is certainly worth investigating. An intensive study of microclimate and its effect on disease spread would also be well worth looking into.

Costs could be reduced still further by more precise application of defoliants and herbicides and by more careful use of harvesting machines. Additional savings could result from improved mechanical means of controlling moisture and trash during harvesting, and better systems of handling and storing seed cotton.

Aside from the need to lower costs, one of our high-priority needs is for structures and equipment for mechanized large-scale production of fresh vegetables under controlled environments. This is particularly important in view of the fact that higher living standards and changing eating habits are creating an increased demand for a year-round supply of fresh vegetables.

Another one of our needs is for greater integration of field and factory operations in order to increase efficiency and to preserve the quality of our processed foods. The use of water tanks to store and transport cherries as they are harvested is a step in this direction.

We also need to have more complete mechanization in transplanting crops such as vegetables, tobacco, and ornamentals; more high-speed precision planting of small seeds; improved equipment and methods for reseeding rangelands and for controlling the plants that clog our waterways.

We need to study and test devices that will produce uniform spray droplets to assure more accurate placement of pesticides, which can help us cut down on the amount used. We also need to look into the possibility of applying pesticides in a form different from the sprays, dusts, or granules that are commonly used today.

Research is needed to develop the biological, physical, and electrical characteristics peculiar to various animals, insects, and plants . . . and to translate this information into usable agricultural techniques for control of insects and improved growth of plants and animals.

And we must not overlook the development of solar collectors, equipment, and heat exchangers so we can apply solar energy to agriculture. Agriculture is currently the Nation's greatest user of non-renewable energy.

In all our work, it becomes increasingly apparent that we can succeed only as we take a broad, comprehensive approach to research. This means a great emphasis upon multidisciplinary research . . . a general broadening of our scientific knowledge . . . and, at the same time, a greater individual specialization.

Agricultural engineers, for example, must not only be highly trained specialists in their fields, but they must also have a working understanding of other disciplines and technologies. The demands upon agricultural engineers are great, indeed, and they are growing all the time.

I would like, in closing, to emphasize my conviction that highly trained scientists working in excellent facilities such as these form an unbeatable combination for the future of agriculture. I hope to see many other research facilities come into operation throughout the country. And I hope that we will always be able to attract the very best minds available to staff these laboratories . . . to keep them alive with the stimulation of new and untried ideas.

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